FAA-1147b
December 20, 1973
SUPERSEDING
FAA-1147a, 8/1/60
and Amendment 1,
4/13/66

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION SPECIFICATION

APPROACH LIGHT SUBSTATION CURRENT REGULATOR UNIT NO. 2

(MOVING COIL TYPE)

1. SCOPE

1.1 Scope.- This specification covers the requirements for a 150 KVA metal-clad, outdoor-type regulator unit of the moving coil type for use in conjunction with and directly connected to a power and control Unit No. 1, Specification FAA-1146b, to form an integrated substation assembly as shown on Drawing D-5205-3. The purpose of the integrated substation is to furnish a source of power and brightness control equipment for the 20 amp. series approach lighting systems, auxiliary station power, and power and controls for a condenser discharge flashing light system.

1.2 Classification.- Type CCRS-3 (Unit 2 M).

2. APPLICABLE DOCUMENTS

2.1 FAA Documents.- The FAA specifications, standard, and drawings of the issues specified in the invitation for bids or request for proposal form a part of this specification.

2.1.1 FAA specifications

FAA-1146b	Approach Light Substation Power and Control Unit No. 1
FAA-D-2494/1	Instruction Book Manuscripts Technical; Equipment and Systems, Requirements, Part I
FAA-D-2494/2	Instruction Book Manuscript Technical; Equipment and Systems, Requirements, Part II

2.1.2 FAA standard

FAA-STD-013	Quality Control Program Requirements

2.1.3 FAA drawings

D-5205-1	Approach Light Substation, Power and Control Unit No. 1 - Layout, Lighting, and Dimensions
D-5205-2	Approach Light Substation, Power and Control Unit No. 1 - Wiring Diagram
D-5205-3	Approach Light Substation, Constant Current Regulator Unit No. 2 - Layout, Lighting and Dimensions
D-5205-4	Approach Light Substation - Constant Current Regulator Unit No. 2 - Wiring Diagram
C-5208	Approach Light Substation - Passageway Between Units 1 and 2 - Construction Details
C-4850	High Voltage Sign
C-4676	Warning Sign
B-21216-H	Standard Name Plate

(Minor changes in the arrangement and spacing of components, in wiring fabrication and construction of this unit as shown on Drawings D-5205-1, D-5205-2, D-5205-3, D-5205-4, and C-5208 may be made as required to meet the operating and/or performance requirements of the specification).

2.2 Military and Federal publications.- The following Military and Federal publications, of the issue in effect on date of the invitation for bids or request for proposals, form a part of this specification.

2.2.1 Military specifications

MIL-C-704 Treatment and Painting of Material

MIL-E-5558 Enamel, Wrinkle-Finish for Aircraft Use

2.2.2 Military standard

MIL-STD-470 Maintainability Program Requirements

2.2.3 Federal specification

TT-E-489 Enamel

2.2.4 Federal standard

FED-STD-595 Colors

2.3 Other publications.- The following publications, of the issue in effect on the date of the invitation for bids or request for proposals, form a part of this specification.

2.3.1 American National Standards Institute (ANSI) Publications

C-37 Switchgear

C-57 American Standards for Transformers, Regulators, and Reactors

2.3.2 National Electrical Manufacturers Association (NEMA) Standard

Standards for Power Switchgear Assemblies

2.3.3 National Board of Fire Underwriters Standard

NFPA No. 70 National Electrical Code

2.3.4 Occupational Safety and Health Act

National Standards Established by Occupational Safety and Health Act (OSHA)

(Copies of this specification and other applicable FAA documents may be obtained from the Contracting Officer in the office issuing the invitation for bids or request for proposals. The requests should fully identify material desired, i.e., standard, drawing, specification and amendment numbers and dates. Request should cite the invitation for bids, request for proposal, or contract involved or other use to be made of the requested material).

(Request for copies of Military specifications should be addressed to Commanding Officer, Naval Supply Depot, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120).

(Information on obtaining copies of Federal specifications and standards may be obtained from General Services Administration office in Washington, D.C.; Atlanta; Auburn, Washington; Boston; Chicago; Denver; Kansas City, Mo.; New York; San Francisco, and Seattle).

(Information on obtaining ANSI Standards will be provided by the American National Standards Institute, 70 East 45th Street, New York, N.Y., and on obtaining the National Electrical Code will be provided by the National Fire Protection Association, 60 Batterymarch Street, Boston, Massachusetts, 02110).

3. REQUIREMENTS

3.1 Materials.- Materials shall be as specified herein. When materials are used that are not specifically designated, they shall be in accordance with the best industrial standards and practices for this type equipment. All metals shall be suitably protected against corrosion.

3.2 Workmanship.- Workmanship shall be in accordance with the highest grade commercial practice covering this type of work.

3.3 Design and construction.-

3.3.1 General.- The regulator unit shall be of the outdoor type, constructed to comprise in one integral unit all of the equipment functionally necessary as shown on Drawings D-5205-3, and -4, and as may be needed to fulfill all requirements of this specification. The over-all unit circuitry and interconnection of components shall be as shown on Drawing D-5205-4. Any additional components and wiring required to accomplish the functions of this unit shall be provided. The protective and monitoring circuits as shown on D-5205-4 are representative of the types now being used, but the actual design of these circuits to fulfill the requirements of this specification is the responsibility of the manufacturer. The low voltage and control interconnecting terminal board to Unit No. 1 shall be marked as shown on Drawing D-5205-4. Any change in circuit design shall not change the function of any connection to this interconnecting terminal board. The design shall be such that similar and associated components are grouped together to reduce the length of connection cables and the number of cross overs. All component parts shall be factory wired and all field connections shall be limited to the interconnection between this unit and power and control Unit No. 1, Specification FAA-1146b. The weatherproof compartments of the unit shall be joined together to form a continuous structure with a workspace in front and access through a passageway to Unit No. 1. The entire underside of

the unit, including the sides and the ends of the channels shall be given a coating of zinc chromate primer, after which a 1/8 inch thick coating of Minnesota Mining & Manufacturing Co., EC-244 or equal asphalt sealing compound shall be applied to prevent corrosion. It shall be designed such that the low voltage equipment is completely separated from high voltage equipment by grounded metallic barriers. All low voltage wiring passing through a high voltage compartment shall be metal enclosed insofar as practical. All low voltage control panels shall be of the dead front type. Metals used in the regulator assembly and its components shall be selected or treated so that no corrosion will result from galvanic action. The design shall follow the maintainability design guidelines in paragraph 5.4 of MIL-STD-470.

3.3.2 Environmental conditions.- The unit assembly shall be capable of satisfactory operation under the following environmental conditions:

3.3.2.1 Temperature.- Any ambient temperature from -55°C (-67°F) to +55°C (+131°F).

3.3.2.2 Altitude.- A pressure altitude ranging from sea level to 3,300 feet.

3.3.2.3 Humidity.- A humidity range from saturation at sea level to saturation at 3,300 feet at a temperature of +55°C (+131°F).

3.3.2.4 Sand and dust.- Exposure to airborne sand particles encountered on deserts.

3.3.2.5 Salt spray.- Exposure to atmosphere containing salt laden moisture.

3.3.2.6 Weather.- Continuous outdoor operation under all weather conditions not previously specified herein.

3.3.3 Physical construction

3.3.3.1 General.- The regulator housing shall consist of a rugged steel framework covered with sheet metal plates of not less than No. 11 thickness U.S. gage steel, front, rear, top, and side panels and steel floor. Flooring in the workspace shall be safety plate steel. The assembly may consist of several smaller units bolted together to form the complete assembly with sloping roof as for standard outdoor metal-clad switchgear and within the maximum dimensions shown on Drawing D-5205-2. The housings shall be weatherproof with necessary ventilation provided by weatherproof screened openings. A weatherproof regulator is so constructed that exposure to the weather will not interfere with its successful operation. Screened weep holes shall be provided in the floor where necessary. All screenings shall be 12 x 12 copper or bronze mesh. No screws or bolts shall be permitted through the top surface of the

regulator enclosure unless welded in place. Sheet metal separators shall be installed between the high voltage, low voltage, and control compartments. The assembly shall be self-supporting and designed for installation on a level concrete pad. A minimum of three six-inch channels shall be attached to the bottom structure of each unit for mounting purposes and with provisions for bolting to pad. Suitable lifting hooks or eyes shall be provided on each assembly for lifting and handling. These shall be located so that the unit may be lifted without tilting or distortion of the unit. All components of the unit shall be rigidly mounted. Bolts used in assembling the heavy parts shall be of sufficient length that at least three full threads will show over the nut after tightening. Lock washers shall be used under all nuts. Base channels of the same dimensional tolerance shall be selected for each of the two Units 1 and 2 if necessary to assure proper mating. When two or more units are purchased, all Units #1 shall mate with all Units #2. Thickness of undercoating on the sides of the channels, front and rear, on each unit shall be the same. The slope of the roof shall be the same on each unit and the type construction employed on each unit shall be such as to present a matched appearance when the two are joined together. All metal parts shall be free from buckling and warping.

3.3.3.1.1 Internal construction.- The unit shall contain all equipment necessary for the purpose of this specification as shown on Drawing D-5205-3, enclosed behind compartmented panelboards. Each of the three series regulators shall be placed in a separate tank and installed within the space limitations shown under alternate construction on the reference Drawing D-5205-3. A door opening on the left end shall be provided for weatherproof entrance to a two-foot long passageway which shall be designed to fasten securely to a similar opening in the right end of the power and control Unit No. 1, Specification FAA-1146b, and as shown on Drawing C-5208. No screws or bolts shall be permitted through the top surface of this unit unless welded in place. A throat connection shall be provided between each of the regulator tanks and the unit compartment assembly as shown on D-5205-3. The throat connection shall completely house all connections, shall contain provisions for separation of low voltage and high voltage cables and shall be weatherproof. It shall also permit disconnection and removal of regulator (or regulators) in event replacement becomes necessary.

3.3.3.1.2 Exterior.- Seams on the exterior of the substation units which are deep seated so as to trap water, or permit rusting (including inaccessible points) shall not be permitted. Caulking compounds will not be accepted in lieu of continuous seam welds or tightly sealed, overlapping raintight joints.

3.3.3.2 Conduit entrances and cable terminations.- Adequate facilities shall be provided in the rear of the left end compartment for the entrance of interconnecting conduits and convenient connection of cables between power and control Unit No. 1, Specification FAA-1146b, and this regulator unit. All conduits shall be equipped with locknuts and

bushings. Space shall be provided in the left end of the regulator unit for entrance of conduits as shown on Drawing D-5205-3. Four terminals shall be furnished in this compartment for connection of incoming 2400/4160V power leads and six terminals for the series output leads for connection to substation Unit No. 1. One No. 2 ground wire and terminal shall be provided in each compartment of the unit and connected to an internal ground bus. This ground bus shall not be used as a separate electrical neutral bus or instead of a separate electrical neutral bus. This internal ground bus shall be a continuous copper bar or wire having a cross sectional area equal to or greater than No. 2 AWG wire and shall run the entire length of the unit connecting to two exterior lugs (one on each end) for connection to the exterior station ground system. Terminal boards with adequate size terminals shall be provided for all control and low voltage power circuits. All cable and wire terminals shall be of the pressure connector tube-type. All cable lugs shall be of the pressure solderless type.

3.3.3.3 Accessibility.- All parts contained within the metal-clad housing shall be easily accessible for maintenance or replacement. No equipment shall be mounted on the back side of dead-front panels, unless the panels are hinged and can be opened to a minimum of 90° swing for maximum accessibility to all components within, or on rear side of panels, or both. All equipment attached to panels where the rear is not readily accessible shall be designed for removal or replacement from the front.

3.3.3.4 Access doors and panels

3.3.3.4.1 Access doors.- Access doors equipped with suitable hinges shall be provided on the assembly for access to all control and low voltage compartments.

The design shall permit opening the access doors to control and low voltage compartments with the regulator unit energized. All such access doors shall have door stops to hold the door in an open position. Access doors which are used as mounts for electrical components making up the electrical system shall be grounded by a suitable flexible bonding strap between such doors and the enclosure frame.

3.3.3.4.2 Interior access panels.- Access panels shall be provided as follows:

(a) To 2.4 KV input and series output line terminals

(b) To compartments housing connections to regulator(s)

Access panels shall be metal plates of equivalent thickness to that of the metal clad enclosure and shall be secured with chrome plated knurled thumbscrews. The knurled thumbscrews shall have a large slotted head with recessed shoulder. They shall be designed to remain in place

when the panels are removed. They shall be received by self-aligning, self-retaining type nuts contained within the structure. Screws that are received by tapped holes within the structures will not be accepted.

3.3.3.4.3 Emergency exit door.- An emergency exit door shall be provided in Unit No. 2 of the dimensions shown and at the approximate location shown on Drawing D-5205-3. This door shall be weatherproof and shall be furnished with panic hardware for quick opening from the inside only and shall open outward. The door shall be spring loaded to close automatically and latch when released in open position. No exterior knobs or locking devices shall be used. The hinges and operating handles shall be designed so as to minimize vandalism or forced entry to the substation. If hinges and attachments are mounted with screws or bolts, they shall be welded or adequately peened-over inside to prohibit removal from the outside. Stencilled on the outside of the door shall be the inscription, "Emergency Exit, Keep Clear of Obstructions." A high voltage warning sign conforming to C-4850 shall be attached above the emergency exit door.

3.3.3.5 Painting.- Rough edges and burrs shall be removed from all surfaces. All surfaces shall be suitably prepared for painting and sprayed with one coat (min.) of rust resistant primer surfacer and dried. When thoroughly dry, all surfaces of the unit shall be painted with one base and one finish coat of insignia white in accordance with Federal Specification TT-E-489 for air drying enamel. Color shall be insignia white No. 17875 Federal Standard No. 595.

3.3.4 Electrical characteristics.- The regulator assembly shall have the characteristics specified herein and shall consist of electrical components having the characteristics specified herein and as necessary to the proper operation of the unit when used in conjunction with Unit No. 1 for meeting all power and control requirements of the integrated substation assembly.

3.3.4.1 Rating.- The regulator assembly shall be capable of supplying three 20-ampere series loops, each with a 50 KW incandescent lamp load through S/S, 20/20 amp. transformers. The neutral circuit and all connections shall be identified in a conspicuous manner throughout. All equipment and circuitry for the input power supply and the 20-ampere series circuits, unless otherwise specified, shall be of the 5 KV insulation class at 3300 feet maximum elevation. The rating of the unit shall be 150 KVA, 2400/4160V, 3Ø, 60 Hz.

3.3.4.2 Performance.- The substation shall perform to supply 20-amperes (maximum) to each of the three series loops under a full 50 KW load (99.5% min. P.F.) and with an input voltage variation of ±5%. In addition to the maximum current of 20-amperes, provision shall be made for the selection of lower constant currents as indicated by number in Table I together with their expected minimum efficiencies. The power factor shall be no less than 0.8 lag on any brightness positions for any load from 50% to 100% of rated load. The power factor shall not be leading for any load from 0% to 100% of rated load. Provision shall be

made for adjusting the output current to the intermediate values T1 through T4 of Table I. The output current of each loop shall be individually adjustable to these intermediate values without affecting either of the loops.

3.3.4.2.1 Series current tolerances.- The assembly shall be designed to hold the various current levels specified for each brightness position within the tolerances given in Table II for each of the load conditions stipulated. All tabulated requirements and current values shall be at rated load under standard conditions which shall be at an ambient temperature of 25°C ± 5°C. The series current tolerance measurements shall be performed as follows: In measuring output current under full load conditions or with 15 of the isolating transformer secondaries open, approximately 10%, a portion of the lamp load, not exceeding two thirds of the total load, may be simulated by an adequate resistance load as specified in 4.3 The resistance will be considered adequate when it provides a voltage drop equal to that which would be experienced by the equivalent number of lamps and isolation transformers in the same circuit at each of the specified current levels.

TABLE I

Step Step	Nominal Output Current (Amperes)	Minimum Over-all Efficiency Per Cent Full Load	50% Load
1	8.3	--	--
T1	9.4	--	--
2	9.9	--1	--
T2	10.6	--	--
3	12.1	--	--
T3	13.2	--	--
4	15.3	--	--
T4	18.3	--	--
5	20.0	90	80

3.3.4.2.2 Open circuit voltage.- The open circuit voltage of the output circuits shall not exceed 3750 volts RMS at any output brightness tap. The limitation of the open circuit voltage shall be accomplished by inherent design features of the regulator and no external voltage limiting devices will be permitted.

TABLE II

OUTPUT CURRENT TOLERANCES FOR EACH OUTPUT SERIES LOOP

Operating Conditions	Maximum Deviations From Nominal Values in Amperes Steps 1-4	Step 5
2400/4160, 3 Ø Input 25°C ± 5°C, Full Load - Position 5	0.4	0.3
Input Voltage Variations ± 5%	0.4	0.4
Load Variations. (Short Circuit to Full Load)	0.4	0.4
During Warm-up (Room Temperature to Operating Temperature of all Parts)	0.4	0.4
10% of Load Isolating Transformers Opened on Each Loop	0.4	0.4
Ambient Temperature Variations (-67°F to +131°F)	0.4	0.4

3.3.4.2.3 Output current surge limitation.- The design of the regulator assembly shall be such that anh output surges caused by switching the regulator on and off, changing brightness taps, or shorting the load, shall not be great enough to damage a 300 watt, 20-amperes series incandescent lamp. Time delays, if any, incorporated when switching the regulator on and off, or changing brightness taps shall not cause a time interval of more than two seconds to elapse before the unit operates to deliver the current selected. Under sudden shorting of the load, the output current shall decay to the normal value in not more than ½ second. It is permissible, however, in changing from one brightness tap to another to deenergize the load circuit up to six cycles or 1/10 second.

3.3.4.3 Electrical components.- The assembly shall consist of all electrical components necessary for the proper operation of the regulator unit to produce the results specified herein.

3.3.4.3.1 Constant current regulator.- A moving-coil type current regulator, complete with all necessary protective and control elements to meet the requirements of this specification shall be provided. The regulator shall be of the self-cooled type and shall conform to all applicable requirements of ASA Standards for Transformers, Regulators, and Reactors. Three separate 20-ampere (max.) 50 KW series output

circuits shall be provided with one appropriately rated current regulator in each series circuit. The current regulator design shall be such that all operational requirements will be met even if the unit is tilted up to five degrees from the vertical. The current regulators shall be installed in separate outdoor type tank attached to the housing unit as detailed herein. The design and installation of leads connecting the moving coil to the fixed terminal bushings of the tanks shall be of such design and material and installed in such a manner that failure in service due to metal fatigue, loosening of parts, contact with fixed parts or other operational conditions, will not occur. Bearing surfaces of the moving element shall be of such material that excessive wear, noise, vibration, erratic operation or failure of these parts will not occur during the normal service life of this equipment.

3.3.4.3.1.1 Core and coil assembly design.- The core and coil design shall be such that the input power circuit is completely isolated (electrically) from the output series circuit and so constructed that the vertical axis of the moving coil coincides or is parallel with the vertical axis of the fixed coil throughout its range of travel. Adjustment of the secondary current shall be made with the unit deenergized and without the removal of any oil. The design shall also incorporate a means for absorbing the shock of repeated deenergizing with the moving coil in the extreme upper position without damage to coils or other components. The design shall be such that temperature rise of the windings measured by the resistance method shall not exceed 65°C in continuous operation for any load up to full load.

3.3.4.3.1.2 Regulator tanks.- The three constant current regulators shall each be installed in a separate ruggedly constructed steel tank having all joints welded and oil tight. The tanks shall be designed for outdoor service. All moving parts of the regulator shall be entirely enclosed within the tank. Suitable lifting hooks or eyes shall be provided for lifting. The regulator shall be oil-insulated and self-cooled, having all necessary oil shipped inside of the regulator. The tank shall be of the pressure-type design capable of withstanding an internal pressure of five pounds per square inch. Each regulator tank shall have an oil valve at the bottom to permit withdrawal of oil. Cooling tubes shall be installed on tanks by the external welding method. The finished weld shall be smooth and entirely free of holes, pits, or cracks in which moisture could be trapped. The regulator, with its tank, shall be removable from Unit #2 without opening the tank or removing any insulating oil.

3.3.4.3.2 Current selection equipment.- The electrical components for the current selection shall be as follows and installed as described.

3.3.4.3.2.1 Autotransformer.- A tapped autotransformer shall be furnished for each series loop to provide the necessary current steps shown in Table I. It shall be in accordance with all applicable requirements of the ASA Standards for Transformers, Regulators and Reactors and shall be of the 5 KV insulation class.

3.3.4.3.2.2 Brightness (Oil) switches.- These electrically operated switches shall have a minimum interrupting rating of 15-amperes at 7500 volts to 50-amperes at 2500 volts and with 120 volt AC operating coils have an inrush current below 10-amperes. These switches shall operate in conjunction with the autotransformer to provide the required current to the series loop for the corresponding brightness tap selected.

3.3.4.3.2.3 Tank.- Any tanks which may be required for the current selection equipment shall meet the requirements of paragraph 3.3.4.3.1.2 above.

3.3.4.3.3 Oil level indicator.- The oil filled compartments housing the major components covered in this section shall have a visual type oil level indicator which can be readily seen without extensive removal of plates, covers, etc. The oil level indicator shall be of the circular meter type (magnetically operated) with an oil seal between indicating dial and inside of oil compartment.

3.3.4.3.4 Metering requirements.- Series output metering potential and current transformers shall be incorporated in the regulator design. The secondary leads of these transformers for metering purposes shall be connected to the terminal board positioned for interconnection to power and control Unit No. 1, Specification FAA-1146b. The terminals for the current transformers shall be provided with a short circuiting device to permit disconnection while energized. The potential transformers shall be 20:1 ratio and the current transformers shall have a current ratio of 25:5. The ratio of error of the instrument transformers shall not exceed 1% for the connected burden.

3.3.4.3.5 Protective devices.- An automatic open circuit protective device shall be provided to prevent damage in the event that an open circuit develops in any of the series load circuits. When set on Position 4 or Position 5, these devices shall open the oil circuit breaker within two seconds after the fault occurs. In the event of open circuits at lower intensities, up to 10 seconds may be permitted before the open circuit protection opens the oil circuit breaker. The device shall be reset electrically by deenergizing the local or remote control circuit, then reenergizing. All low voltage wiring and devices used in conjunction with this protective device shall be isolated from the high voltage by suitable two-winding transformers, 5 KV insulated, and by grounded metallic or suitably insulated wireways. Protection against damage to any or all components shall be provided in the event two or more brightness steps are accidentally selected at any one time due to failure of some portion of the control system.

Special protective devices shall be incorporated in the circuitry to protect rectifiers and relays against switching and lightning surges. The circuit shall provide protection against voltages up to 2000 volts. A demonstration of the effectiveness of this protection will be required at the time of the prototype inspection.

3.3.4.3.6 Capacitors.- Capacitors for other than power factor correction shall have a voltage rating at least 25 percent higher than normal working voltage. Adequate cooling shall be provided to insure long life. Electrolytic capacitors are not acceptable, except electrolytic capacitors are permitted in control circuits.

3.3.4.3.7 Interior lights.- Interior lights and convenience outlets shall be as shown on Drawing D-5205-3. One overhead heavy duty 100 watt wire guard light shall be provided with toggle switch at the entrance to the unit. Wiring shall be No. 12 RHW installed in ½ inch rigid heavy wall galvanized steel conduit.

3.3.4.4 Electrical wiring.- High voltage wiring shall be adequately supported with insulated bushings between connections, or encased in metal raceways or conduits. Any open wiring through bulkheads and metal panels shall be made using procelain bushings or other approved wire insulating bushings free from sharp edges. Sharp bends in insulated wires are prohibited. All wires connected to screw type terminals shall be properly lugged. All low voltage power and control wiring shall be terminated in suitable terminal blocks and shall be readily accessible from the interior workspace of the unit. All internal connections may be made on terminal blocks or type General Electric Co., Model #614C788 or equal. The pressure connector tube-type shall be used for all external connections. When insulation is removed from wire for the purpose of making connections, care shall be taken to see that the copper condictor is not nicked or cut in any way. In the event it becomes necessary to run low voltage or control wires into high voltage compartments (such as CT and PT leads, etc.) they shall be isolated insofar as practical from high voltage wiring by grounded metallic or suitably insulated wireways. Splices in high voltage conductors shall be kept to an absolute minimum. All high voltage joints shall be taped where practical with insulating and flame resistant material in amount to obtain full insulation value in accordance with industry standards.

3.3.4.4.1 Marking and stencilling.- All equipment components (relays, meters, switches, etc.) shall be clearly identified by removable nameplates or bold permanent type stencils throughout. Identification markings shall agree with designations on diagrams and in parts lists. Phasing shall be shown in like manner for all such equipment and circuitry throughout the substation. All control wires shall be provided with end identifications in the form of a plastic band around the wire with identifying markings permanently stamped thereon, or with the markings permanently stamped onto the wire itself. All power cables shall be similarly marked except that a permanently stamped rigid laminate tag may be attached near the cable ends in lieu of the above. The terminating points for all wires and cables at terminal blocks or equipment terminals shall be clearly and permanently identified corresponding to the circuit and terminal designations as shown on wiring diagrams. The internal wiring of components such as relays, contactors, and breakers, etc., need not

be marked but all wiring connecting thereto shall be. Sizes of all fuses shall be stenciled adjacent to fuse blocks on mountings.

3.3.4.5 Load monitoring.- The regulator unit shall contain the necessary monitoring equipment to automatically provide indication that the sub-station is energized and carrying a connected load on each series loop which may range as low as 30% of the loop lamp capacity. The desired indication shall be transmitted through terminal "IM" and relays of power and control Unit No. 1 to parallel connected green gull's eye lights on the remote control panel. These lights shall (a) Light when all three loops are carrying the load for which monitoring adjustment has been made and (b) not light if the load in any one loop has fallen below that point due to open lamp insulating transformers. The monitoring system shall be adjustable to indicate an outage of from 4 to 10 lamps in each loop, ±1 lamp, on brightness Step 5. The monitoring system shall also operate to indicate lamp outage on reduced brightness steps. Because the monitoring circuit will require more lamps to be out to operate on a reduced brightness step than it does on Step 5, the upper limit of 10 lamps may be exceeded on all reduced brightness steps. The monitoring adjustment shall be a device located on the control panel of this unit, shall be readily accessible and operated without difficulty. It is desired that the monitor system begin operating simultaneously with the energizing of the regulator unit, however, if necessary to prevent false indication of load conditions when approach lights are first turned on, a time delay of up to 30 seconds will be permitted. The dual green lights on the local control panel shall provide simultaneous indication.

3.3.4.6 Under-voltage tap.- In order to compensate for unusually low supply voltage, an under-voltage tap with phase-to-ground voltage of 2150 volts shall be provided in the regulator tank.

3.3.4.7 Control.- A control system shall be furnished with switchgear Unit No. 1 which shall provide positive and instantaneous control either from a remote point or locally at power and control Unit No. 1, Specification FAA-1146b. The control in conjunction with the controls provided in this unit shall provide for turning approach lights on and off, and selection of five positions of brightness, and monitoring equipment as detailed in Specification FAA-1146b for power and control Unit No. 1. Position indicator lights for the respective brightness positions shall be operated by appropriate contacts on current selector relays or devices of Regulator Unit No. 2. The design shall be such that the incoming H.V. supply to the regulator unit will not be interrupted during any of the control operations, except when approach lights are turned off or when deenergizing the integrated assembly of Units 1 and 2. Power for performing all local control operations shall be furnished by the 10 KVA auxiliary and control power transformer located in power and control Unit No. 1.

3.4 Nameplates.- A stainless steel or brass nameplate, permanently and legibly filled in with the following information, shall be securely

attached to each regulator unit. A suitable reference shall be made to the instruction booklet which is to be furnished with each unit and, in addition to this, a wiring diagram of the power circuit shall be added showing the connections to all high voltage terminals. The nameplate shall be made up in accordance with Drawing B-21216 except as stated or shown herein.

Constant Current Regulator Substation Unit No. 2
(Moving Coil Type)

Type CCRS-3 (Unit 2M)
Specification FAA-1147b
Input - 3 Phase, 2400/4160 V, 60 Hz 150 KVA
Output - 20A, Series 3-- 50 KW Circuits
FAA Contract No. Quantity
Manufacturer's Part No.
Manufacturer's Name or Trade Mark
Instruction Book No.
Federal Stock No.

3.5 Instruction book manuscripts.- Instruction book manuscripts shall be furnished in accordance with Specification FAA-D-2494/1 and /2.

3.5.1 Instruction books.- The government will reproduce and prepare instruction books from the manuscript copy (3.5) and furnish copies to the contractor for shipment with the equipment. Two instruction books shall be included with each set of equipment comprising a system.

4. QUALITY ASSURANCE PROVISIONS

4.1 General.- The contractor shall provide and maintain a quality control program which fulfills the requirements of FAA-STD-013, Quality Control Program Requirements. The contractor's quality control program shall be a scheduled and disciplined plan of events integrating all necessary inspections and tests required to substantiate product quality during design, development, purchasing, subcontracting manufacture, fabrication, processes, assembly, acceptance, packaging, and shipping. The contractor shall perform or have performed the inspections and tests required to substantiate product requirements and shall also perform or have performed all inspection and tests otherwise required by the contract.

4.2 Tests.- The prototype of the complete substation (Units No. 1 and 2) shall be inspected and tested at one location for conformance with all requirements under the contract. High voltage supply power of sufficient capacity and voltage shall be available as well as adequate resistance and 300 watt, 20/20A, series/series transformer loads to permit variation from no load to full load, and open secondary tests on transformers as required for testing monitor effectiveness. The two prototype units (No. 1 and 2) shall be fully interconnected both physically and electrically for the operational tests. The testing may be performed one phase at a time if desired.

4.2.1 Design qualification.- The following tests shall be conducted on the pre-production sample to prove compliance with the requirements of this specification.

4.2.1.1 Examination of product.- The assembly shall be thoroughly examined to check conformance with all basic design (3.3.1) and physical (3.3.3) requirements of this specification.

4.2.1.2 Environmental tests.- Tests of the entire unit to prove conformance under the environmental conditions specified in 3.3.2 will not be required except for the test in paragraph 4.2.1.2.1, however, the manufacturer shall furnish a certification that the unit will give satisfactory performance under all environmental conditions specified.

4.2.1.2.1 Rain test.- The rain test shall be conducted on the complete substation assembly (No. 1 and 2 units) (3.3.3.1) fully connected physically. The unit shall be checked for water tightness (within the meaning of NEMA definition SG-5-1.018) by simulating a driving rain on all exterior joints, doors, bolted panels and on the enclosures in general. This test shall be in accordance with Underwriters Bulletin #23 entitled, "Rain Test of Electrical Equipment, Method and Apparatus." The requirements of this paragraph apply to any throat connection provided between the constant current regulators and the unit compartment, as well as to the compartment structure.

4.2.1.3 Dielectric test.- The assembly shall be given an applied 60 cycle Hz voltage test for one minute on the following circuits and at the voltage specified

High Voltage Equipment and Power Wiring (Includes Series Output Equipment and Wiring)	19 KV
Low Voltage Equipment and Power Wiring.	1.5 KV
Control Equipment and Control Wiring (Components incapable of taking this high voltage shall be disconnected before the test).	1.0 KV

4.2.1.4 Electrical performance test.- The unit shall be energized at 2400/4160 V (±5%) for normal operation from simulated control as specified in power and control Unit No. 1. Tests shall be conducted to prove conformance with all operating requirements specified in 3.3.4.2, 3.3.4.2.1, 3.3.4.2.3, 3.3.4.3.5, 3.3.4.5, and 3.3.4.7. This test may be performed one phase at a time if desired.

4.2.1.5 Heat runs.- A temperature rise test on the No. 2 unit shall be performed on all windings independently to show that the temperature rise of any component part of the assembly does not exceed that specified in ASA Standards for Transformers, Regulators, and Reactors under any of the specified input voltage and local conditions. The test may be

conducted on the constant current regulator unit (3.3.4.3.1) by itself but this unit shall be performed in accordance with ASA requirements. When the regulator consists of three identical single phase units, each in a separate tank, the test may be run on one of the single phase units. Temperature rise of all windings shall be obtained by the resistance method as follows:

$$\text{Temperature Rise } (^{o}C) = (234.5 + O_o) \quad \frac{(R1 - R_o)}{R_o}$$

Where O_o = Temperature (^{o}C) corresponding to Cold Resistance

R_o = Cold Resistance

R_1 = Hot Resistance

4.2.1.6 Standard impulse test.- This test shall be performed, unless otherwise specified, as described in ASA Standards for Transformers, Regulators, and Reactors, and ASA Standards for switchgear for the specified insulation class of the equipment. Impulse tests may be performed on the individual electrical components (3.3.4.3) before final assembly of the unit or on the completed assembly at the discretion of the contractor.

The impulse tests may be conducted at a location other than that designated for the prototype inspection; however, the equipment shall be adequate for performing all impulse tests required under the referenced ASA Standards for this type equipment, including the chopped wave tests. Photographic facilities shall also be available for taking pictures of the impulse test shots including visual observation of the applied waves.

4.2.1.7 Open circuit test.- To determine that the open circuit voltage limitation has not been exceeded, a test shall be performed as follows:

(a) Place the regulator on each of the five tap positions with the regulator delivering load to the lamp circuit

(b) By-pass or defeat the open circuit protecting relaying scheme

(c) Open the loop circuit (load) by using a disconnect switch or other disconnecting device

(d) Read and record the RMS voltage output of the regulator for each of the tap positions specified in (a)

4.2.1.8 Power factor test.- The Unit 2 shall be tested to assure that the power factor requirements specified in 3.2.4.2 are met.

4.2.2 Standard acceptance tests of production units.- Each production unit shall be subjected to the same tests prescribed above for the pre-production sample except the rain test, heat run test, tower factor test, and impulse test. Acceptance testing on all production units shall likewise be performed at one location having high voltage power supply and load facilities as required for the pre-production model. Each No. 1 unit shall be connected electrically and mechanically with a No. 2 unit for operational testing under 4.2.1.4 of each unit specification. A master template shall be used to verify that all Units #1 will mate with all Units #2 if more than one system is purchased.

5. PREPARATION FOR DELIVERY

5.1 Application.- The packaging, packing, and marking requirements specified herein apply only to direct purchases by or direct shipment to the government.

5.2 Packaging.- Each regulator unit shall be commercially packaged. Containers shall conform to the requirements of Consolidated Freight Classification Rules in effect at the time of shipment. All relays and other internal parts shall be suitably blocked or packed to prevent damage.

The regulator assembly shall be shipped complete with oil in all components which require oil.

5.3 Packing.- The regulator shall be packed for domestic shipment unless otherwise specified. Exterior containers, insofar as possible, shall be uniform in size and shape, and shall contain one regulator and accessories. Containers shall conform to the requirements of Consolidated Freight Classification Rules in effect at the time fo shipment and shall be designed to insure acceptance by common carrier for safe transportation at the lowest rate to the point of delivery.

The units are to be shipped separately and the openings to the walkwat shall be securely closed for water-tight storage and shipment. Wood covers, not less than ½ inch thick, shall be used to close these openings. All doors to be secured in closed position for shipment. Skids for moving and shipping shall be of hardwood.

5.4 Marking.- Containers shall be durably and legibly marked with the following information:

Constant Current Regulator Substation Unit No. 2
(Moving Coil Type)
Type CCRS-3 (Unit 2M)
Specification FAA-1147b
Manufacturer's Part No. _____
FAA Contract No. _____
Manufacturer's Name or Trade Mark _____

Metal tags bearing the serial number of the substation shall be fastened to the door handle of the No. 1 unit and also to the plywood panel covering the passageway entrance to Unit No. 2 so as to be conspicuous from outside the crates.

6. NOTES

6.1 Options.- In using this specification, purchasing officers should take special care to exercise all options. Options to be considered are as follows:

Paragraph	
4.2.1.2	Delete Rain Test if not required
4.2.1.5	Delete heat run if not required
4.2.1.6	Delete impulse test if not required
5.3	Packing if other than for domestic shipments

* * * * *

THIS PAGE LEFT BLANK INTENTIONALLY.

TABLE OF CONTENTS